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DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[The technical field to which invention belongs] this invention relates to the structure of a plastic optical fiber base material, its manufacture method, and the plastic optical fiber field drawing method.

[0002]

[Description of the Prior Art] Since the handling of connection is simple, the plastic optical fiber by which the core section and the clad section are constituted from plastic material is used for comparatively short-distance communication of the enclosure (Local Area Network) of LAN etc. As shown in drawing 2 (A), generally such a plastic optical fiber 20 is a wire rod with an outer diameter [with the concentric circle-like two-layer structure of the core section 21 of the outside clad section 22 and the interior] of 0.3-1.0mm, it forms covering 23 outside further and practical use is presented with it. The core section 21 used as the transmission line of the main light is equipped with the structure which shuts up the light which a refractive index spreads highly from the surrounding clad section 22. That in which the core section the configuration of a distribution of this refractive index indicates a conceptual diagram to be to this drawing (B) has the step index type refractive-index distribution with a refractive index higher than the clad-section stair-like is put in practical use, and the thing with an equipped with the refractive-index distribution of parabolic which has maximum at center of core which shows conceptual diagram in this drawing (C) in which information transmission of high capacity is still more possible gray DIDO type refractive-index distribution is proposed.

[0003] It is common to manufacture by the method of forming beforehand the base material of a plastic optical fiber which consists of the core section which has a publication in JP,08-106015,A as the manufacture method of these plastic optical fibers, and the clad section, and drawing a line by heating melting and carrying out spinning of this. Drawing 3 is drawing having shown the outline of a drawing facility of a plastic optical fiber. In the steady state according to which the plastic optical fiber of good quality is manufactured with the same outer diameter The base material feeder 31 inserts the base material 30 in the heating furnace 32 at a fixed speed. on the other hand, a hitch 35 Tuning finely so that the outer diameter of the plastic optical fiber 38 on which a line was drawn based on the measurement result of the outer-diameter measuring device 33 may be kept constant, the speed, i.e., the drawing speed, of a hitch 35 A plastic optical fiber 38 is led at the rate of the simultaneously regularity corresponding to the ratio of the outer diameter of a base material 30, and the outer diameter of a plastic optical fiber 38, and it rolls round by the machine reel 37.

[0004] At the time of the start of drawing, first, as shown in drawing 4 (A), a base material 30 puts point part 30A on the portion of a heating furnace 32 most heated by the elevated temperature perpendicularly by the base material feeder 31, and is held. If the temperature of the seed material portion 40 which hits the edge of point part 30A in this state rises more than a softening temperature, it will soften and the seed material portion 40 will fall by self-weight, as shown in this drawing (B) and (C). Then, as shown in this drawing (D), base material point part 30A becomes the configuration of the shape of a tapering approximate circle drill, pulls out the filamentous portion 39 which has pulled and got down from this base material point part 30A to this seed material portion 40 as it is, is led to a hitch 35, starts towage, and starts the spinning of a plastic optical fiber. This work of a series of is called seed ore shoot.

[0005]

[Problem(s) to be Solved by the Invention] However, in the seed ore-shoot work of such a plastic optical fiber, it needed to heat over the long time until the seed material portion fell by the self-weight, and a stop time is [the facility to the start of drawing] long, and there was a problem of a low in manufacturability.

[0006] Moreover, since it was heated unlike the steady drawing state where it is led from a base material nose of cam, and spinning of the plastic optical fiber is carried out as a product, without a base material moving within a heating furnace by heating for a seed ore shoot for a long time, temperature went up in the latus range near a base material nose of cam, and the phenomenon in which the amount of [of an approximate circle drill configuration] base material point became long just behind a seed ore shoot had happened. The configuration for a base material point of a steady state where a good plastic optical fiber was manufactured differed from the state just behind a seed ore shoot, and since the ratio of clad and a core changed until it results in a steady state, there was a problem that the good plastic optical fiber of a transmission characteristic could not be manufactured. Moreover, time until it will be from a seed ore shoot in a steady state could not manufacture a product at all, but the drawing facility had the problem to which productivity becomes low.

[0007] furthermore , since near a base material nose of cam be heated in a heating furnace for a long time , this foam and coloring

made the increase in transmission loss, and the fall of mechanical strength produce also in a portion with proper plastic optical fiber outer diameter which the coloring by generating of the foam by the pyrolysis of material etc. or oxidization of material might arise in the portion used as a product, and be obtained and ratio of the core section and the clad section, and it had become the problem of a quality side. Furthermore, different prolonged heating from a steady state advanced bridge formation of the plastic material which constitutes a base material, and produced near the point part of a base material, and the difference of the softening property of an interstitial segment, and the problem on manufacture -- it will be necessary to change the temperature of a heating furnace during drawing etc. -- had produced it. It was discarded without using many portions of the manufactured base material as a good plastic optical fiber, as a result of these problems' arising, and the yield was low and a problem in respect of productivity and cost.

[0008]

[Means for Solving the Problem] Then, artificers shorten the time which a seed ore shoot requires in view of the above-mentioned technical problem, and accomplish this invention for the purpose of manufacturing a good plastic optical fiber with the sufficient yield.

[0009] That is, this invention is a base material of a plastic optical fiber used for making it soften by heating and manufacturing a plastic optical fiber, and is characterized by the low thing as compared with the softening temperature of the interstitial segment of the base material with which spinning of the softening temperature of the seed material portion at the nose of cam of a base material is carried out to a plastic optical fiber product. Furthermore, this invention is the drawing method of a plastic optical fiber, and the softening temperature of the seed material portion at the nose of cam of a base material which is softened and is dropped is characterized by the small thing as compared with the softening temperature of the interstitial segment of the base material by which spinning is carried out to a plastic optical fiber product. Moreover, in the drawing method of this plastic optical fiber, the weight average molecular weight of the plastic material of the seed material portion at the nose of cam of a base material is good [after infiltrating the solvent which the material of a plastic optical fiber dissolves in the seed material portion at the nose of cam of a base material, it is good also considering introducing a base material in the aforementioned heating furnace as a feature, and] also considering a small thing as a feature as compared with the interstitial segment of a base material.

[0010] According to this invention person's knowledge, it becomes possible to perform a seed ore shoot by short-time heating by making low the softening temperature for a base material point, and the time which a seed ore shoot takes can be shortened. Since the heating time near [which results in a seed ore shoot] a base material nose of cam can be shortened simultaneously, and the elevation of the temperature of the interstitial segment close to a part for a point cannot deform easily small, the length of the approximate circle drill type portion for a base material point becomes a thing near the configuration of a steady state, and drawing on steady conditions can start it after a seed ore shoot early. Moreover, the foam simultaneously produced in prolonged heating and the problem of oxidization can be prevented.

[0011]

[Embodiments of the Invention] Drawing 1 is drawing having shown typically the situation in the heating furnace before and behind a seed ore shoot. as for the inside of drawing (B-1), field 13B which showed the state just before seed material partial 10 of base material 11B by conventional technology B falls, and were shown by hatching have softened in heating by the prolonged heating furnace 12. Here, since temperature falls as it separates from the center of a heating furnace to the upper part, as the portion into which temperature rises more than a softening temperature is shown in 13B, the rate of the clad section of the outside heated directly becomes high. For this reason, as a result of the material of the long section containing many clad plates softening and falling as a seed, the configuration at the nose of cam of a base material just behind a seed ore shoot is set to long and slender approximate circle drill type partial 16B. while [then,] a line is drawn on the material shown by hatching on which a line will be drawn by the time approximate circle drill type partial 16B just behind a long and slender seed ore shoot becomes the configuration at the nose of cam of a base material of the steady state shown with a dashed line -- a clad member and a core -- steady states differ comparatively and the rate of a member cannot perform manufacture of a good product. For this reason, the yield of the process which draws a line in a plastic optical fiber becomes a low thing very much.

[0012] On the other hand, the field of hatching which drawing 1 (A-1) showed the state just before the kind at the time of using base material 11A of this invention falls, and was shown by 13A has reached the softening temperature by heating. In the base material of this invention, since low kind material partial 10A of the softening temperature at the nose of cam of a base material softens at low temperature from the interstitial segment 14 used as a product, the field which has softened the interstitial segment side which should result in the state in front of fall of a seed for a short time, and should serve as a product from the case of the above-mentioned conventional technology as a result becomes narrow. As a result, if there are few portions which will be discarded by the time it results in the steady state shown in a steady state by near and 15A and they start drawing as shown in this drawing (A-2), the manufacture of a product of the configuration of the base material just behind a seed ore shoot will be attained for a short time.

[0013] If the softening temperature of the seed material for a base material point is a plastic optical fiber on which a line is drawn at 150-250 degrees C, 10-degree-C or more low and the above operations cannot be discovered from the interstitial segment used as a product, and they cannot fall [only 50 degrees-C or more low and a seed material portion can soften, and], and it cannot pull out the thread material connected at the nose of cam of an interstitial segment. For this reason, it is desirable not to attach the low material of a different softening temperature at all, but to prepare the low-of-the-same-kind material of the softening temperature which adds processing so that a softening temperature may fall to the seed material portion at the nose of cam of a base material, or is easy to carry out melting unification with a base material, to make this unify at the nose of cam of a base material, and to

consider as seed material. A softening temperature here is JIS. It is the temperature defined as temperature by which temperature is changed using the equipment used for the melt index measuring method of K-7210, using a load as 2160g, and 1g discharge quantity is observed in 10 minutes, and, as for time until a plastic optical fiber is introduced into a heating furnace and seed material falls, in a low, this softening temperature becomes earlier.

[0014] The drawing method of the plastic optical fiber base material by this invention and a plastic optical fiber is based on the above-mentioned knowledge. namely, as a concrete means to fall the softening temperature for a base material point, the softening temperature of the part equivalent to the seed material of a base material point By changing into the state where sprayed the solvent which the material of a plastic optical fiber dissolves, or repeated being immersed and dryness, made it sink into a part for a base material point, and a part for a base material point was made to swell with a solvent Compared with the interstitial segment which is not included by the amount of [containing the solvent] point, a softening temperature can obtain a low base material. As a combination of such a plastic optical fiber material and a solvent, there are an acetone, a methyl ethyl ketone, a tetrahydrofuran, a methyl isobutyl ketone, a dioxane, a monochlorobenzene, ethyl acetate, etc. to the plastic optical fiber material of an acrylic-acid system.

[0015] Moreover, by making lower than an interstitial segment weight average molecular weight of the plastic material which constitutes a part for a base material point, the glass transition point of the plastic material of this portion can be lowered, and a softening temperature can be reduced. In case the polymerization of the liquefied resin material is carried out and a base material is specifically manufactured, about a part for the base material point of a polymerization container, the nose of cam of a polymerization container in which this portion was held is contacted on a low-temperature wall surface, by holding polymerization temperature low, the rate of polymerization for a base material point can be reduced, and weight average molecular weight can be lowered. Or by preparing plastic material with beforehand small weight average molecular weight at the nose of cam of a base material, and forming an interstitial segment so that this may be followed, the weight average molecular weight of the plastic material for a base material point can manufacture a small base material as compared with the interstitial segment of a base material, and in case the low portion of such weight average molecular weight manufactures resin material for a part for a base material point by the polymerization, it can be manufactured by blending a lot of chain transfer agents compared with an interstitial segment etc. The weight average molecular weight for a point of a base material is a book, such as being able to give the difference in sufficient softening temperature, if it is 70% or less of the weight average molecular weight of an interstitial segment, and bringing a seed ore shoot forward, here. This weight average molecular weight can be easily measured by liquid chromatography etc.

[0016] Although an example is given and this invention is explained hereafter, this invention is not limited to these examples. (Example 1) The clad-plate mixed solution which first added n-butyl mercaptan (n-BM) which are 0.5 % of the weight and a chain transfer agent about the G t-butyl peroxide (DBP) which is a polymerization initiator 0.2% of the weight to methyl methacrylate (MMA) was created. Putting this into the glass tube which is the bore of 30mm by which one end was closed, making a plug the non-closing edge of a glass tube, setting the medial axis of a glass tube horizontally, and making it rotate at the rate of 1500 revolutions per minute centering on a shaft, it puts on 90-degree C atmosphere for 20 hours, the polymerization was carried out to it, and the clad plate of the shape of a pipe with the outer diameter of 30mm, a bore [of 14mm], and a length of 400mm was created. The number average molecular weight of the resin which makes a clad plate was 100,000. Next, the core material mixed solution which added to MMA n-BM which is 0.5 % of the weight and a chain transfer agent about DBP which are 25 % of the weight and a polymerization initiator about the benzyl benzoate (BEN) which is a high refractive-index component 0.2% of the weight is created, it poured into a part for the centrum of the clad plate of the shape of a pipe in the state where it went into the glass tube manufactured previously, and it held perpendicularly in a 90-degree C oil bath, and heated, and the polymerization of the core material was carried out. Then, the base material of the plastic optical fiber of the shape of a cylinder with an outer diameter [of 30mm] and a length of 400mm was obtained by removing a glass tube.

[0017] Grasping the manufactured base material perpendicularly and rotating it, the acetone was sprayed on 50mm portion of noses of cam which hits seed material over 10 minutes, and the acetone was infiltrated into a part for a base material point. The base material which contains an acetone in a part for this base material point was attached in drawing equipment, when the temperature of the nitrogen gas which filled the inside of a furnace put the base material on the predetermined position of a heating furnace where an interstitial segment is heated so that it may become 200 degrees which is the optimal temperature for drawing a line as a product, and it started the seed ore shoot, the seed fell in 20 minutes and the seed ore shoot was completed. Under the present circumstances, foaming was looked at by the portion of the seed material which fell by volatilization of an acetone. Moreover, the time taken for drawing speed and the base material speed of supply to have become a fixed ratio, and to stabilize a drawing state as a result of continuing drawing by part for 7m/in drawing speed after that was 30 minutes. It is 0.28mm of a design value, and manufacture of a good product was possible for the core diameter of the plastic optical fiber manufactured at this time, and it was able to continue drawing for this succeedingly and was able to manufacture the plastic optical fiber with an outer diameter of 0.60mm 680m. Thus, the obtained plastic optical fiber was cut every 50m, the transmission loss of each portion was connected to one end of a plastic optical fiber as the light source which excites laser diode with a luminescence wavelength of 650nm in the regular mode, Idemitsu from the other end was received by the power meter, and transmission loss was measured as compared with the case where a plastic optical fiber is not connected. Consequently, it has checked that the transmission loss of the plastic optical fiber after a drawing state is stabilized covered an overall length, and had an optical property good in km and 150dB /or less.

[0018] Moreover, it has checked acquiring a low value to 200 degrees C and 220 degrees C of a base material interstitial

segment, as a result of measuring the softening temperature of a portion which hits the seed material for a point of the base material which the acetone was infiltrated similarly independently and manufactured. It was 50mm, when the length of the approximate circle drill type portion for a base material point just behind a seed ore shoot was defined as the distance to the part set to 3mm from the part where a base material outer diameter becomes 28mm and was furthermore measured. Moreover, when the length of the approximate circle drill type portion for a point of the base material which is drawing a line by the steady state was measured similarly, a result is 45mm and was changing only a part for the base material point just behind a seed ore shoot, and 5mm. Thus, according to the technique shown in the example 1, it has checked that long manufacture of shortening of seed ore-shoot time using the high drawing equipment of facility cost and a good product was possible by the simple processing for about 10 minutes.

[0019] (Example 1 of comparison) The base material of a plastic optical fiber was created by the same method as an example 1, it attached in the drawing equipment made into the same conditions as an example 1, without doing only the blasting sinking-in work of an acetone, drawing was performed with the seed ore shoot, and the plastic optical fiber with an outer diameter of 0.60mm was manufactured. Time until it drops a seed required long time to 45 minutes and the example 1. Moreover, since the amount of [of a base material] point softened in the latus range, the configuration for a base material point just behind the seed ore shoot measured using another base material manufactured similarly was as long as 120mm compared with the case where the length of an approximate circle drill type portion is an example 1. 45 minutes was taken to draw a line to the steady state by which drawing speed is stabilized in the base material which has this long approximate circle drill type portion. a part for the base material point which will have been softened in the case of a seed ore shoot if this supplies a base material quickly -- a **** omission ***** sake -- a fixed speed -- a base material -- not supplying -- it is for approaching the steady state with which do not obtain but it is gradually decided by the ratio of a base material outer diameter and a plastic optical fiber outer diameter as a result that drawing speed will be On the other hand, after starting drawing at regular speed, compared with the core section, a plastic optical fiber with many rates of the clad section will be manufactured, and the long approximate circle drill type portion took 15 more minutes, by the time the path of the core layer which can be used as a product which is the outer diameter of 0.60mm was set to 0.28**0.1mm of a design value and it could manufacture the good product. This is because bridge formation of base material material, decomposition, etc. arose partially by prolonged heating and change arose [that the ratio of the core section and the clad section was confused at the time of a seed ore shoot,] at the flowability in a softening state. When the transmission loss of the plastic optical fiber equivalent to such a part was measured by the same method as an example 1, km was exceeded in 300dB /, or the part which exceeds 50dB locally in the several cm section was generated, and the property with a good transmission characteristic top was not acquired. Consequently, the good product has been manufactured only 400m. That is, when the technology of an example 1 was used by this invention as collected into Table 1, the improvement of 170% of yield is, and 70% of yield could be checked to the example 1 of comparison, and the effect of the invention in this application has been checked.

[0020] (Example 2) Making the 5cm section at the nose of cam of a base material equivalent to the seed material portion of the plastic optical fiber base material before manufacturing by the same method as an example 1 and infiltrating an acetone rotate a base material, the acetone was sprayed over 10 hours and the front face was changed into the state where it wetted wet with the acetone. Then, this base material was dried with the vacuum dryer heated at 60 degrees C for 24 hours. The outer diameter for a base material point after this processing became small [28mm] from 30mm of origin, as a result of the material of a base material dissolving in an acetone and flowing into a base material in parallel to an acetone sinking in. Thus, as a result of measuring the softening temperature of the seed material portion at the obtained nose of cam of a base material, it was 190 degrees C. As a result of drawing a line by attaching this base material in a drawing facility like an example 1, the time taken to go up to a part for 7m/with a regular drawing speed as short [the time to fall of a seed] as 15 minutes was 20 minutes. That seed ore-shoot time became short is the effect of the acetone having sunk in to the interior of a base material, having made plastic material swelling a base material, and having reduced the softening temperature of a seed material portion. Moreover, it is presumed because it resulted in the configuration of a steady state easily closely with the drawing state further that the time which stabilization of drawing speed requires became short even if the configuration for a point of a base material compares with an example 1.

[0021] The transmission loss which cut the plastic optical fiber which the good plastic optical fiber could manufacture 790m from the base material of this example 2, and was manufactured every 50m, and measured it like the example 1 was good in km and 150dB /or less about all the sections. As compared with the example 1 of comparison, the yield of a good article has improved this result sharply twice [about] with 198%. It is what followed one base material for evaluation, the sinking-in method of the solvent carried out in this example can give the sinking-in effect of the same solvent using meanses, such as repeating being immersed and raising for many base materials to a solvent tub at once industrially, and processing of a lot of base materials is possible for it at a low cost.

[0022] (Example 3) The seed material mixed solution which first added n-BM which is 2.0 % of the weight and a chain transfer agent about DBP which is a polymerization initiator 0.2% of the weight to MMA was created. This was put into the 50mm section from the bottom of the glass tube which is the bore of 30mm by which one end was closed, and it held perpendicularly in a 90-degree C oil bath, and heated for 20 hours, and the polymerization of the seed material which consists of a polymethylmethacrylate was carried out. In composition of this seed material, there were more amounts of polymerization initiators and amounts of chain transfer agents than the core material mixed solution and clad-plate mixed solution which were used for composition of the core section of the interstitial segment using the same combination as an example 1, and the clad

section, the crosslinking density of the polymerization product of a seed material portion fell by this, and number average molecular weight was set to 30,000. Moreover, the softening temperature of this seed material portion fell with 200 degrees C. According to the manufacture method of an example 1, the core section the clad section and inside the shape of a pipe was created using the same clad-plate mixed solution of combination as an example 1, and the core material mixed solution using between [of the seed material portion of a glass tube] absentminded, and the base material of a plastic optical fiber with an equipped with the seed material which consists of a 50mm polymethylmethacrylate at a nose of cam outer diameter [of 30mm], and an overall length of 400mm was manufactured.

[0023] The time which the seed ore shoot took this base material as a result of drawing a line by carrying out a seed ore shoot like an example 1 using a drawing facility was 30 minutes, and time until it reaches the drawing speed of a steady state was 30 minutes. Moreover, the 600m good plastic optical fiber was able to be obtained. According to this method, incidental processing of solvent processing etc. can improve productivity without a required process, hardly including the core section which blended the high high refractive-index component of material cost with the portion dropped as seed material. Moreover, unnecessary addition of a new facility], since being immersed [oil bath / which is used for manufacture of the core section] can perform composition of a seed material portion, since simultaneous manufacture of many base materials is possible, there is an advantage with high productivity.

[0024] (Example 4) When the softening temperature of the core section shown in the example 1 and the clad section was measured, the softening temperature of the core section which contains a benzyl benzoate 25% of the weight created the base material of a plastic optical fiber only for seed material using the mixed solution for core material of an example 1 by the same method as 190 degrees C and the example 3 since it is low. The time which took this to perform a seed ore shoot, to complete a seed ore shoot in 15 minutes as a result of drawing a line succeeding, and for drawing speed to rise to a steady state with a drawing facility like an example 3 was 20 minutes. Moreover, the plastic optical fiber with a good transmission characteristic has been manufactured 760m. This technique has an advantage with easy preparation and storage of the non-hardening resin solution which serves as a raw material by using the low core material mixed solution of the softening temperature of a hardened material as a seed material mixed solution.

[0025]

[Table 1]

	種材部分の軟化温度	種落しまでの時間	種落し後、良好製品を得るまでの時間	良好製品長	比較例1を100%とした良好製品長比率
実施例1	200度	20分	30分	680m	170
実施例2	190度	15分	20分	790m	198
実施例3	200度	30分	30分	600m	150
実施例4	190度	15分	20分	760m	190
比較例1	220度	45分	45分	400m	100

[0026]

[Effect of the Invention] As mentioned above, according to this invention, by offering the low base material of the softening temperature of a seed material portion, a seed ore shoot is made for a short time, and manufacture of the good plastic optical fiber product in the drawing speed of a steady state is attained for a short time. Moreover, since prolonged heating for a seed ore shoot is avoided, oxidation or decomposition of a base material do not arise but the ratio of the clad section near a base material nose of cam and the core section is stabilized, the length of the good plastic optical fiber which can be taken from a base material can be made to increase by about 40%. Thereby, productivity and the yield improve and it becomes possible to manufacture a quality plastic optical fiber by the low cost.

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CLAIMS

[Claim(s)]

[Claim 1] The plastic optical fiber base material characterized by the low thing as compared with the softening temperature of the interstitial segment of the aforementioned base material with which it is the base material of the plastic optical fiber used for the manufacture of a plastic optical fiber which is made to soften using a heating furnace and carries out spinning, and spinning of the softening temperature of the seed material portion at the aforementioned nose of cam of a base material is carried out to a plastic optical fiber product.

[Claim 2] The plastic optical fiber base material according to claim 1 with which it sinks in and the solvent which the aforementioned plastic optical fiber dissolves in the aforementioned seed material portion is characterized by the bird clapper.

[Claim 3] The plastic optical fiber base material according to claim 1 with which the aforementioned seed material portions are the aforementioned base material and a material of the same kind, and are characterized by the bird clapper from the low material of weight average molecular weight.

[Claim 4] The manufacture method of the plastic optical fiber base material which is the manufacture method of the base material of the plastic optical fiber used for the manufacture of a plastic optical fiber which is made to soften using a heating furnace and carries out spinning, and is characterized by infiltrating the solvent which the aforementioned plastic optical fiber dissolves in the seed material portion at the aforementioned nose of cam of a base material, and making the softening temperature of the aforementioned seed agent portion lower than the softening temperature of the interstitial segment of the aforementioned base material by which spinning is carried out to a plastic optical fiber product.

[Claim 5] The manufacture method of the plastic optical fiber base material which is the manufacture method of the base material of the plastic optical fiber used for the manufacture of a plastic optical fiber which is made to soften using a heating furnace and carries out spinning, and is characterized by the amount of [of the aforementioned base material] point manufacturing from the interstitial segment of the aforementioned base material to the interstitial segment of the aforementioned base material, and one using the material of the low homotypic of weight average molecular weight.

[Claim 6] The drawing method of the plastic optical fiber by which it is using [the softening temperature of the seed material portion at the nose of cam of a base material which is the drawing method of the plastic optical fiber which is made to soften the nose of cam of the base material of the plastic optical fiber held in the heating furnace, is dropped as seed material, and starts drawing of a plastic optical fiber, is made to carry out softening and is dropped / aforementioned / as the aforementioned base material]-as compared with softening temperature of interstitial segment of aforementioned base material by which spinning is carried out to plastic optical fiber product-low base material characterized.

[Claim 7] The drawing method of the plastic optical fiber according to claim 6 characterized by introducing the aforementioned base material in the aforementioned heating furnace after infiltrating the solvent which the material of the aforementioned plastic optical fiber dissolves in the seed material portion at the aforementioned nose of cam of a base material.

[Claim 8] The drawing method of a plastic optical fiber according to claim 6 that weight average molecular weight of the plastic material of the seed material portion at the aforementioned nose of cam of a base material is characterized by the small thing as compared with the interstitial segment of the aforementioned base material.

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] It is drawing for explaining the gestalt of operation of this invention as compared with a Prior art. The softening state of the softening state of the base material point according [(A-1)] to this invention, the base material point just behind the seed ore shoot according [(A-2)] to this invention, and the base material point according [(B-1)] to the conventional technology and (B-2) are the base material points just behind the seed ore shoot by the conventional technology.

[Drawing 2] It is drawing explaining a plastic optical fiber. (A) is [a step type refractive-index distribution and (C of the cross-section structure of a plastic optical fiber and (B))] gray dead mold refractive-index distributions.

[Drawing 3] It is drawing explaining a drawing facility of a plastic optical fiber.

[Drawing 4] It is drawing explaining the seed ore shoot of a plastic optical fiber. (A), (B), (C), and (D) show configuration change of a base material point after heating of a base material point is started until it results in an approximate circle drill-like configuration.

[Description of Notations]

- 10A: Seed material portion
- 10B: Seed material portion
- 11A: Base material
- 11B: Base material
- 12: Heating furnace
- 13A: The portion which reached the softening temperature
- 13B: The portion which reached the softening temperature
- 14: Interstitial segment
- 15A: The portion discarded by the steady state
- 15B: The portion discarded by the steady state
- 16A: The portion of approximate circle drill type
- 16B: The portion of approximate circle drill type
- 20: Plastic optical fiber
- 21: Core section
- 22: Clad section
- 23: Covering
- 30: Base material
- 30A: A part for a base material point
- 31: Base material feeder
- 32: Heating furnace
- 33: Outer-diameter measuring device
- 34: Guide idler
- 35: Hitch
- 37: Machine reel
- 38: Plastic optical fiber
- 39: Filamentose portion
- 40: Seed material portion

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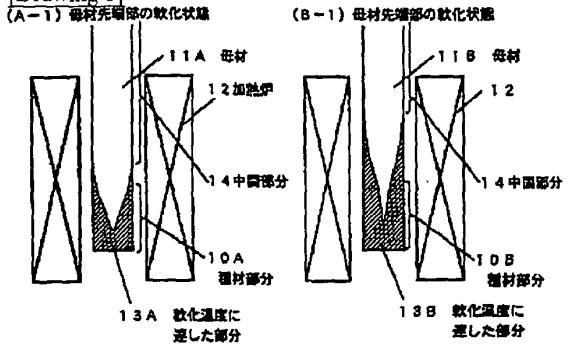
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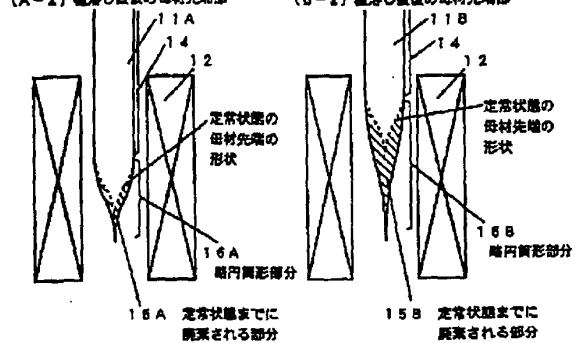
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DRAWINGS

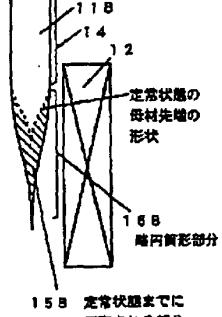
[Drawing 1]



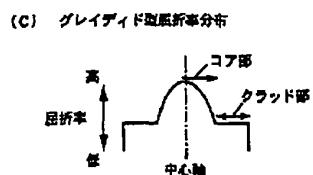
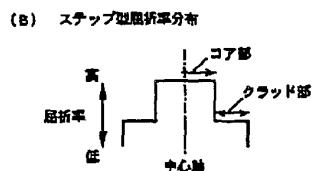
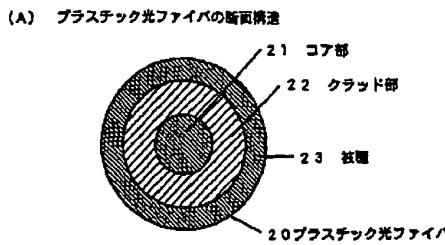
(A-2) 硬化直後の母材先端部



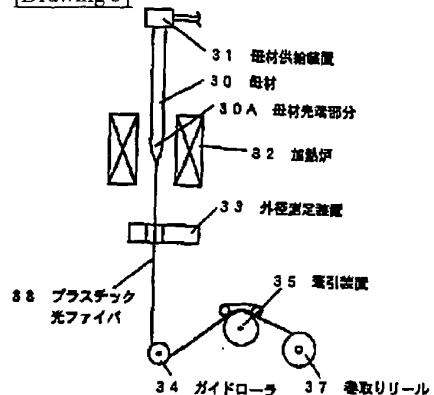
(B-2) 硬化直後の母材先端部



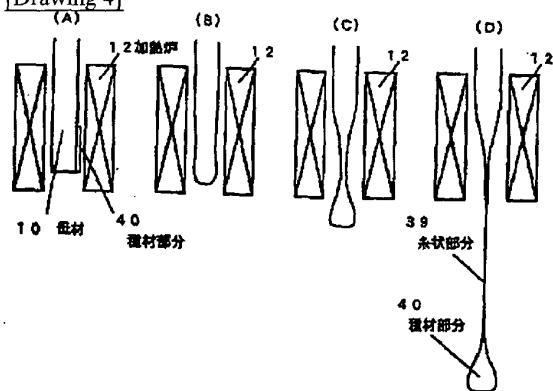
[Drawing 2]



[Drawing 3]



[Drawing 4]



[Translation done.]

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TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] However, in the seed ore-shoot work of such a plastic optical fiber, it needed to heat over the long time until the seed material portion fell by the self-weight, and there was a problem that a stop time was [the facility to the start of drawing] long, and manufacturability was low.

[0006] Moreover, since it was heated unlike the steady drawing state where it is led from a base material nose of cam, and spinning of the plastic optical fiber is carried out as a product, without a base material moving within a heating furnace by heating for a seed ore shoot for a long time, temperature went up in the large range near a base material nose of cam, and the phenomenon in which the amount of [of an approximate circle drill configuration] base material point became long just behind a seed ore shoot had happened. The configuration for a base material point of a steady state where a good plastic optical fiber was manufactured differed from the state just behind a seed ore shoot, and since the ratio of clad and a core changed until it results in a steady state, there was a problem that the good plastic optical fiber of a transmission characteristic could not be manufactured. Moreover, time until it will be from a seed ore shoot in a steady state could not manufacture a product at all, but the drawing facility had the problem to which productivity becomes low.

[0007] furthermore , since near a base material nose of cam be heated in a heating furnace for a long time , this air bubbles and coloring made the increase in transmission loss , and the fall of mechanical strength produce also in a portion with proper plastic optical fiber outer diameter which the coloring by generating of the air bubbles by the pyrolysis of material etc. or oxidization of material might arise in the portion used as a product , and be obtained and ratio of the core section and the clad section , and it had become the problem of a quality side . Furthermore, different prolonged heating from a steady state advanced bridge formation of the plastic material which constitutes a base material, and produced near the point part of a base material, and the difference of the softening property of an interstitial segment, and the problem on manufacture -- it will be necessary to change the temperature of a heating furnace during drawing etc. -- had produced it. It was discarded without using many portions of the manufactured base material as a good plastic optical fiber, as a result of these problems' arising, and the yield was low and a problem in respect of productivity and cost.

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MEANS

[Means for Solving the Problem] Then, artificers shorten the time which a seed ore shoot requires in view of the above-mentioned technical problem, and accomplish this invention for the purpose of manufacturing a good plastic optical fiber with the sufficient yield.

[0009] That is, this invention is a base material of a plastic optical fiber used for making it soften by heating and manufacturing a plastic optical fiber, and is characterized by the low thing as compared with the softening temperature of the interstitial segment of the base material with which spinning of the softening temperature of the seed material portion at the nose of cam of a base material is carried out to a plastic optical fiber product. Furthermore, this invention is the drawing method of a plastic optical fiber, and the softening temperature of the seed material portion at the nose of cam of a base material which is softened and is dropped is characterized by the small thing as compared with the softening temperature of the interstitial segment of the base material by which spinning is carried out to a plastic optical fiber product. Moreover, in the drawing method of this plastic optical fiber, the weight average molecular weight of the plastic material of the seed material portion at the nose of cam of a base material is good [after infiltrating the solvent which the material of a plastic optical fiber dissolves in the seed material portion at the nose of cam of a base material, it is good also considering introducing a base material in the aforementioned heating furnace as a feature, and] also considering a small thing as a feature as compared with the interstitial segment of a base material.

[0010] According to this invention person's knowledge, it becomes possible to perform a seed ore shoot by short-time heating by making low the softening temperature for a base material point, and the time which a seed ore shoot takes can be shortened. Since the heating time near [which results in a seed ore shoot] a base material nose of cam can be shortened simultaneously, and elevation of the temperature of the interstitial segment close to a part for a point cannot deform easily small, the length of the approximate circle drill type portion for a base material point becomes a thing near the configuration of a steady state, and drawing on steady conditions can start it after a seed ore shoot early. Moreover, the foam simultaneously produced in prolonged heating and the problem of oxidization can be prevented.

[0011]

[Embodiments of the Invention] Drawing 1 is drawing having shown typically the situation in the heating furnace before and behind a seed ore shoot. as for the inside of drawing (B-1), field 13B which showed the state just before seed material partial 10 of base material 11B by conventional technology B falls, and were shown by hatching have softened in heating by the prolonged heating furnace 12. Here, since temperature falls as it separates from the center of a heating furnace to the upper part, as the portion into which temperature rises more than a softening temperature is shown in 13B, the rate of the clad section of the outside heated directly becomes high. For this reason, as a result of the material of the long section containing many clad plates softening and falling as a seed, the configuration at the nose of cam of a base material just behind a seed ore shoot is set to long and slender approximate circle drill type partial 16B. while [then,] a line is drawn on the material shown by hatching on which a line will be drawn by the time approximate circle drill type partial 16B just behind a long and slender seed ore shoot becomes the configuration at the nose of cam of a base material of the steady state shown with a dashed line -- a clad member and a core -- steady states differ comparatively and the rate of a member cannot perform manufacture of a good product For this reason, the yield of the process which draws a line in a plastic optical fiber becomes a low thing very much.

[0012] On the other hand, the field of hatching which drawing 1 (A-1) showed the state just before the kind at the time of using base material 11A of this invention falls, and was shown by 13A has reached the softening temperature by heating. In the base material of this invention, since low kind material partial 10A of the softening temperature at the nose of cam of a base material softens at low temperature from the interstitial segment 14 used as a product, the field which has softened the interstitial segment side which should result in the state in front of fall of a seed for a short time, and should serve as a product from the case of the above-mentioned conventional technology as a result becomes narrow. As a result, if there are few portions which will be discarded by the time it results in the steady state shown in a steady state by near and 15A and they start drawing as shown in this drawing (A-2), the manufacture of a product of the configuration of the base material just behind a seed ore shoot will be attained for a short time.

[0013] If the softening temperature of the seed material for a base material point is a plastic optical fiber on which a line is drawn at 150-250 degrees C, 10-degree-C or more low and the above operations cannot be discovered from the interstitial segment used as a product, and they cannot fall [only 50 degrees-C or more low and a seed material portion can soften, and], and it cannot pull out the thread material connected at the nose of cam of an interstitial segment. For this reason, it is desirable not to attach the low material of a different softening temperature at all, but to prepare the low of-the-same-kind material of the softening temperature

which adds processing so that a softening temperature may fall to the seed material portion at the nose of cam of a base material, or is easy to carry out melting unification with a base material, to make this unify at the nose of cam of a base material, and to consider as seed material. A softening temperature here is JIS. It is the temperature defined as temperature by which temperature is changed using the equipment used for the melt index measuring method of K-7210, using a load as 2160g, and 1g discharge quantity is observed in 10 minutes, and, as for time until a plastic optical fiber is introduced into a heating furnace and seed material falls, in a low, this softening temperature becomes earlier.

[0014] The drawing method of the plastic optical fiber base material by this invention and a plastic optical fiber is based on the above-mentioned knowledge, namely, as a concrete means to fall the softening temperature for a base material point, the softening temperature of the part equivalent to the seed material of a base material point By changing into the state where sprayed the solvent which the material of a plastic optical fiber dissolves, or repeated being immersed and dryness, made it sink into a part for a base material point, and a part for a base material point was made to swell with a solvent Compared with the interstitial segment which is not included by the amount of [containing the solvent] point, a softening temperature can obtain a low base material. As a combination of such a plastic optical fiber material and a solvent, there are an acetone, a methyl ethyl ketone, a tetrahydrofuran, a methyl isobutyl ketone, a dioxane, a monochlorobenzene, ethyl acetate, etc. to the plastic optical fiber material of an acrylic-acid system.

[0015] Moreover, by making lower than an interstitial segment weight average molecular weight of the plastic material which constitutes a part for a base material point, the glass transition point of the plastic material of this portion can be lowered, and a softening temperature can be reduced. In case the polymerization of the liquefied resin material is carried out and a base material is specifically manufactured, about a part for the base material point of a polymerization container, the nose of cam of a polymerization container in which this portion was held is contacted on a low-temperature wall surface, by holding polymerization temperature low, the rate of polymerization for a base material point can be reduced, and weight average molecular weight can be lowered. Or by preparing plastic material with beforehand small weight average molecular weight at the nose of cam of a base material, and forming an interstitial segment so that this may be followed, the weight average molecular weight of the plastic material for a base material point can manufacture a small base material as compared with the interstitial segment of a base material, and in case the low portion of such weight average molecular weight manufactures resin material for a part for a base material point by the polymerization, it can be manufactured by blending a lot of chain transfer agents compared with an interstitial segment etc. The weight average molecular weight for a point of a base material is a book, such as being able to give the difference in sufficient softening temperature, if it is 70% or less of the weight average molecular weight of an interstitial segment, and bringing a seed ore shoot forward, here. This weight average molecular weight can be easily measured by liquid chromatography etc.

[0016] Although an example is given and this invention is explained hereafter, this invention is not limited to these examples. (Example 1) The clad-plate mixed solution which first added n-butyl mercaptan (n-BM) which are 0.5 % of the weight and a chain transfer agent about the G t-butyl peroxide (DBP) which is a polymerization initiator 0.2% of the weight to methyl methacrylate (MMA) was created. Putting this into the glass tube which is the bore of 30mm by which one end was closed, making a plug the non-closing edge of a glass tube, setting the medial axis of a glass tube horizontally, and making it rotate at the rate of 1500 revolutions per minute centering on a shaft, it puts on 90-degree C atmosphere for 20 hours, the polymerization was carried out to it, and the clad plate of the shape of a pipe with the outer diameter of 30mm, a bore [of 14mm], and a length of 400mm was created. The number average molecular weight of the resin which makes a clad plate was 100,000. Next, the core material mixed solution which added to MMA n-BM which is 0.5 % of the weight and a chain transfer agent about DBP which are 25 % of the weight and a polymerization initiator about the benzyl benzoate (BEN) which is a high refractive-index component 0.2% of the weight is created, it poured into a part for the centrum of the clad plate of the shape of a pipe in the state where it went into the glass tube manufactured previously, and it held perpendicularly in a 90-degree C oil bath, and heated, and the polymerization of the core material was carried out. Then, the base material of the plastic optical fiber of the shape of a cylinder with an outer diameter [of 30mm] and a length of 400mm was obtained by removing a glass tube.

[0017] Grasping the manufactured base material perpendicularly and rotating it, the acetone was sprayed on 50mm portion of noses of cam which hits seed material over 10 minutes, and the acetone was infiltrated into a part for a base material point. The base material which contains an acetone in a part for this base material point was attached in drawing equipment, when the temperature of the nitrogen gas which filled the inside of a furnace put the base material on the predetermined position of a heating furnace where an interstitial segment is heated so that it may become 200 degrees which is the optimal temperature for drawing a line as a product, and it started the seed ore shoot, the seed fell in 20 minutes and the seed ore shoot was completed. Under the present circumstances, foaming was looked at by the portion of the seed material which fell by volatilization of an acetone. Moreover, the time taken for drawing speed and the base material speed of supply to have become a fixed ratio, and to stabilize a drawing state as a result of continuing drawing by part for 7m/in drawing speed after that was 30 minutes. It is 0.28mm of a design value, and manufacture of a good product was possible for the core diameter of the plastic optical fiber manufactured at this time, and it was able to continue drawing for this succeedingly and was able to manufacture the plastic optical fiber with an outer diameter of 0.60mm 680m. Thus, the obtained plastic optical fiber was cut every 50m, the transmission loss of each portion was connected to one end of a plastic optical fiber as the light source which excites laser diode with a luminescence wavelength of 650nm in the regular mode, Idemitsu from the other end was received by the power meter, and transmission loss was measured as compared with the case where a plastic optical fiber is not connected. Consequently, it has checked that the transmission loss of the plastic optical fiber after a drawing state is stabilized covered an overall length, and had an optical property good in km and

150dB /or less.

[0018] Moreover, it has checked acquiring a low value to 200 degrees C and 220 degrees C of a base material interstitial segment, as a result of measuring the softening temperature of a portion which hits the seed material for a point of the base material which the acetone was infiltrated similarly independently and manufactured. It was 50mm, when the length of the approximate circle drill type portion for a base material point just behind a seed ore shoot was defined as the distance to the part set to 3mm from the part where a base material outer diameter becomes 28mm and was furthermore measured. Moreover, when the length of the approximate circle drill type portion for a point of the base material which is drawing a line by the steady state was measured similarly, a result is 45mm and was changing only a part for the base material point just behind a seed ore shoot, and 5mm. Thus, according to the technique shown in the example 1, it has checked that long manufacture of shortening of seed ore-shoot time using the high drawing equipment of facility cost and a good product was possible by the simple processing for about 10 minutes.

[0019] (Example 1 of comparison) The base material of a plastic optical fiber was created by the same method as an example 1, it attached in the drawing equipment made into the same conditions as an example 1, without doing only the blasting sinking-in work of an acetone, drawing was performed with the seed ore shoot, and the plastic optical fiber with an outer diameter of 0.60mm was manufactured. Time until it drops a seed required long time to 45 minutes and the example 1. Moreover, since the amount of [of a base material] point softened in the latus range, the configuration for a base material point just behind the seed ore shoot measured using another base material manufactured similarly was as long as 120mm compared with the case where the length of an approximate circle drill type portion is an example 1. 45 minutes was taken to draw a line to the steady state by which drawing speed is stabilized in the base material which has this long approximate circle drill type portion. a part for the base material point which will have been softened in the case of a seed ore shoot if this supplies a base material quickly -- a **** omission ***** sake -- a fixed speed -- a base material -- not supplying -- it is for approaching the steady state with which do not obtain but it is gradually decided by the ratio of a base material outer diameter and a plastic optical fiber outer diameter as a result that drawing speed will be On the other hand, after starting drawing at regular speed, compared with the core section, a plastic optical fiber with many rates of the clad section will be manufactured, and the long approximate circle drill type portion took 15 more minutes, by the time the path of the core layer which can be used as a product which is the outer diameter of 0.60mm was set to $0.28**0.1$ mm of a design value and it could manufacture the good product. This is because bridge formation of base material material, decomposition, etc. arose partially by prolonged heating and change arose [that the ratio of the core section and the clad section was confused at the time of a seed ore shoot,] at the flowability in a softening state. When the transmission loss of the plastic optical fiber equivalent to such a part was measured by the same method as an example 1, km was exceeded in 300dB /, or the part which exceeds 50dB locally in the several cm section was generated, and the property with a good transmission characteristic top was not acquired. Consequently, the good product has been manufactured only 400m. That is, when the technology of an example 1 was used by this invention as collected into Table 1, the improvement of 170% of yield and 70% of yield could be checked to the example 1 of comparison, and the effect of the invention in this application has been checked.

[0020] (Example 2) Making the 5cm section at the nose of cam of a base material equivalent to the seed material portion of the plastic optical fiber base material before manufacturing by the same method as an example 1 and infiltrating an acetone rotate a base material, the acetone was sprayed over 10 hours and the front face was changed into the state where it wetted wet with the acetone. Then, this base material was dried with the vacuum dryer heated at 60 degrees C for 24 hours. The outer diameter for a base material point after this processing became small [28mm] from 30mm of origin, as a result of the material of a base material dissolving in an acetone and flowing into a base material in parallel to an acetone sinking in. Thus, as a result of measuring the softening temperature of the seed material portion at the obtained nose of cam of a base material, it was 190 degrees C. As a result of drawing a line by attaching this base material in a drawing facility like an example 1, the time taken to go up to a part for 7m/with a regular drawing speed as short [the time to fall of a seed] as 15 minutes was 20 minutes. That seed ore-shoot time became short is the effect of the acetone having sunk in to the interior of a base material, having made plastic material swelling a base material, and having reduced the softening temperature of a seed material portion. Moreover, it is presumed because it resulted in the configuration of a steady state easily closely with the drawing state further that the time which stabilization of drawing speed requires became short even if the configuration for a point of a base material compares with an example 1.

[0021] The transmission loss which cut the plastic optical fiber which the good plastic optical fiber could manufacture 790m from the base material of this example 2, and was manufactured every 50m, and measured it like the example 1 was good in km and 150dB /or less about all the sections. As compared with the example 1 of comparison, the yield of a good article has improved this result sharply twice [about] with 198%. It is what followed one base material for evaluation, the sinking-in method of the solvent carried out in this example can give the sinking-in effect of the same solvent using meanses, such as repeating being immersed and raising for many base materials to a solvent tub at once industrially, and processing of a lot of base materials is possible for it at a low cost.

[0022] (Example 3) The seed material mixed solution which first added n-BM which is 2.0 % of the weight and a chain transfer agent about DBP which is a polymerization initiator 0.2% of the weight to MMA was created. This was put into the 50mm section from the bottom of the glass tube which is the bore of 30mm by which one end was closed, and it held perpendicularly in a 90-degree C oil bath, and heated for 20 hours, and the polymerization of the seed material which consists of a polymethylmethacrylate was carried out. In composition of this seed material, there were more amounts of polymerization

initiators and amounts of chain transfer agents than the core material mixed solution and clad-plate mixed solution which were used for composition of the core section of the interstitial segment using the same combination as an example 1, and the clad section, the crosslinking density of the polymerization product of a seed material portion fell by this, and number average molecular weight was set to 30,000. Moreover, the softening temperature of this seed material portion fell with 200 degrees C. According to the manufacture method of an example 1, the core section the clad section and inside the shape of a pipe was created using the same clad-plate mixed solution of combination as an example 1, and the core material mixed solution using between [of the seed material portion of a glass tube] absentminded, and the base material of a plastic optical fiber with an equipped with the seed material which consists of a 50mm polymethylmethacrylate at a nose of cam outer diameter [of 30mm], and an overall length of 400mm was manufactured.

[0023] The time which the seed ore shoot took this base material as a result of drawing a line by carrying out a seed ore shoot like an example 1 using a drawing facility was 30 minutes, and time until it reaches the drawing speed of a steady state was 30 minutes. Moreover, the 600m good plastic optical fiber was able to be obtained. According to this method, incidental processing of solvent processing etc. can improve productivity without a required process, hardly including the core section which blended the high high refractive-index component of material cost with the portion dropped as seed material. Moreover, unnecessary addition of a new facility], since being immersed [oil bath / which is used for manufacture of the core section] can perform composition of a seed material portion, since simultaneous manufacture of many base materials is possible, there is an advantage with high productivity.

[0024] (Example 4) When the softening temperature of the core section shown in the example 1 and the clad section was measured, the softening temperature of the core section which contains a benzyl benzoate 25% of the weight created the base material of a plastic optical fiber only for seed material using the mixed solution for core material of an example 1 by the same method as 190 degrees C and the example 3 since it is low. The time which took this to perform a seed ore shoot, to complete a seed ore shoot in 15 minutes as a result of drawing a line successively, and for drawing speed to rise to a steady state with a drawing facility like an example 3 was 20 minutes. Moreover, the plastic optical fiber with a good transmission characteristic has been manufactured 760m. This technique has an advantage with easy preparation and storage of the non-hardening resin solution which serves as a raw material by using the low core material mixed solution of the softening temperature of a hardened material as a seed material mixed solution.

[0025]

[Table 1]

	種材部分の軟化温度	種落しまでの時間	種落し後、良好製品を得るまでの時間	良好製品長	比較例1を100%とした良好製品長比率
実施例1	200度	20分	30分	680m	170
実施例2	190度	15分	20分	790m	198
実施例3	200度	30分	30分	600m	150
実施例4	190度	15分	20分	760m	190
比較例1	220度	45分	45分	400m	100

[Translation done.]